SPECIAL REPORT ARLCB-SP-81030

INDEX TO BENET WEAPONS LABORATORY (LCWSL) TECHNICAL REPORTS - 1980

R. D. Neifeld
Technical Publications and Editing Unit

July 1981

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
LARGE CALIBER WEAPON SYSTEMS LABORATORY
BENÉT WEAPONS LABORATORY
WATERVLIET, N. Y. 12189

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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This is a compilation of Benet Weapons Laboratory technical reports published during 1980.

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1. REPORT NUMBER ARLCB-TR-80001	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
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7. AUTHOR(s) Dr. G. C. Carofano		8. CONTRACT OR GRANT NUMBER(s)
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Impulse Noise
Blast Simulator
Rocket Launcher
Recoilless Rifles

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Using the Benet Weapons Laboratory blast simulator, a study was made to determine the noise reducing characteristics of various geometrical extensions to the tube of a VIPER rocket launcher. It was found that a simple straight extension was the most effective. The reduction is achieved by moving the noise source downstream by the length of the extension and by turning the flow axially which modifies the disturbance which travels upstream.

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1. REPORT NUMBER ARLCB-TR-80002	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* STRESS SINGULARITY AT THE VERTEX OF A FLAT WEDGE-SHAPED CRACH BY VARIATIONAL METHOD		5. TYPE OF REPORT & PERIOD COVEREO 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) M. A. Hussain B. Noble S. L. Pu		8. CONTRACT OR GRANT NUMBER(s)
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Presented at 1979 ASME-CSME Applied Mech/Bioengineering Conf/Fluid Eng Conf, Niagara Hilton Hotel, Niagara Falls, NY, 18-20 June 1979.
Presented at 2nd MACSYMA Users' Conf, Washington, DC, 20-22 June 79.
To be published in an open literature journal.

19. KEY WOROS *(Continue on reverse side if necessary and identify by block number)*

Variational Method
Flat-Wedge-Shaped Crack
Stress Intensity Factors
Fracture Mechanics
Papkovitch Stress Functions
Spherical Harmonics
Mixed Boundary Value Problems

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Three dimensional elasticity problems are generally complex. In this paper we present the analysis for the stress singularity at the apex of a three dimensional, flat, wedge-shaped crack under general loadings. The problem is reduced to a set of coupled dual integral equations. Because of the complexity they are not amenable to a closed form solution. A variational method is developed to handle such problems. The physical interpretation of the results is also presented.

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1. REPORT NUMBER: ARLCB-TR-80003
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3. RECIPIENT'S CATALOG NUMBER:
4. TITLE *(and Subtitle)*: M201 Cannon Land Damage - a first Look
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7. AUTHOR(s): M. A. Hussain and S. L. Pu
8. CONTRACT OR GRANT NUMBER(s):
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Cannon Tube - M201
Contact Stress
Compliance
Land Damage
Ramming Velocity
Equivalent Velocity
Projectile Kinetic Energy

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The objective of this preliminary investigation is to compute by analytic techniques the conditions which will lead to land damage either in the axial or the radial mode under fully or partially autofrettaged conditions and to estimate the safe ramming velocities.

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3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: Simulation of Partial Autofrettage Residual Stresses by Thermal Loads	5. TYPE OF REPORT & PERIOD COVERED
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): M. A. Hussain, J. D. Vasilakis, S. L. Pu, P. O'Hara	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Benet Weapons Laboratory, Watervliet Arsenal, Watervliet, N.Y. 12189, DRDAR-LCB-TL	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 6111.01.91A0.0, D.A. Project 1L161101A91A, PRON NO. 1A-9-2ZA01-Y
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Autofrettage
Residual Stresses
Thermal Stresses

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The effect of favorable residual stresses of an autofrettaged tube is well known. In many instances there is a redistribution of these stresses due to changes of geometrical configurations such as the presence of keyways, riflings, cracks, etc. The problem, in general, can be studied by discretization carried out either by finite elements or by finite differences; however, it is usually not possible to incorporate the redistributed residual stress patterns due to the presence of such geometrical changes. This

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20. Abstract (Cont'd)

difficulty is overcome by simulation of residual stresses by certain active loadings.

The simulation by dislocation and equivalent thermal loading for a fully autofrettaged tube is well known. In this report we extend the thermal loading to simulate a partially autofrettaged case. The simplicity of the method is illustrated by comparing numerical results to those obtained from finite elements (NASTRAN) and finite differences.

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4. TITLE *(and Subtitle)* Stress Analyses of O.D. Notched Thick-Walled Cylinders Subjected to Internal Pressure or Thermal Loads		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. A. Kapp and G. A. Pflegl		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 61102H420011 DA Project 1L161102AH42 PRON No. 1A217141A1A
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18. SUPPLEMENTARY NOTES

To be presented at the Pressure Vessel Conference ASME, San Francisco, August 1980

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Autofrettage
Finite Elements
NASTRAN
Thermal Stress
Stress Concentration Factor

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Finite element stress analysis has been performed to determine the effects of two OD notch configurations in a cylinder subjected to internal pressure, or containing autofrettage residual stress. The effects on the residual stresses were determined by simulating these stresses with active temperature loads. The results show that the deeper of the two notch configurations is far more severe resulting in a maximum stress concentration factor of 5.8. The shallower notch has a maximum stress concentration factor of 3.5.

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20. ABSTRACT (Cont'd)

An additional result is that by introducing notches in autofrettaged cylinders a significant amount of the residual stresses are relieved which indicates that smaller applied pressures can be contained by these cylinders, than in smooth cylinders before yielding occurs. The results also show that the possibility of OD initiated fatigue failure is greatly increased.

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-TR-80006
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): Evaluation and Demonstration of Tampella 81mm and 120mm Mortar Systems (U)
5. TYPE OF REPORT & PERIOD COVERED:
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): E. G. Frezon
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9. PERFORMING ORGANIZATION NAME AND ADDRESS: Benet Weapons Laboratory, Watervliet Arsenal, Watervliet, N. Y. 12189, DRDAR-LCB-TL
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11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Research and Development Command, Large Caliber Weapon System Laboratory, Dover, New Jersey 07801
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number):
Mortar Systems
Mortar Ammunition
Mortar Test Data
20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

Reports of an improved 81mm TAMPELLA Mortar System having a maximum range of 6500 meters resulted in the establishment of a project with the U. S. Army Foreign Science and Technology Center for procurement/evaluation of this system. Contact and negotiations with ETABLISSEMENT SALGAD (Sales Organization for TAMPELLA Mortars) eventually led to a limited test and demonstration at Aberdeen Proving Ground of the TAMPELLA 81mm and 120mm Mortar Systems. The 81mm and 120mm Mortars demonstrated maximum ranges of 6575 meters and 8107 meters respectively with

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good accuracy. Arena fragmentation tests to evaluate the lethality of a controlled fragmentation (COFRAM) round for the TAMPELLA 81mm Mortar revealed this round to be significantly more lethal than the U. S. 81mm M374 PMI cartridge.

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4. TITLE (and Subtitle) Development and Operation of 8 Inch Laboratory ESR Furnace at Watervliet Arsenal		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) W. Sullivan V. Colangelo		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Research and Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervliet, N.Y. 12189		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 3297.06.7550 DA Project. PRON No. M1-5-A1731
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon System Laboratory Dover, New Jersey 07801		12. REPORT DATE March 1980 13. NUMBER OF PAGES 31
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

ESR Melting
Steel Castings
Slag
Hollow Steel Ingots
Servo Systems
Furnace (ESR)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is an evaluation of a contractor furnace (ESR) for use in laboratory experiments in melting solid and hollow ingots. The report describes the condition of the furnace as installed, the problems encountered together with the design changes made in-house to correct the existing deficiencies. The report also indicates the technical areas that must be explored to fully develop a hollow ingot technology.

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-TR-80008	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): IMPROVED LC CHROMIUM FOR GUN TUBE APPLICATION	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): E. S. Chen, W. Baldauf	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Benet Weapons Laboratory, Watervliet Arsenal, Watervliet, NY 12189, DRDAR-LCB-TL	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 611102H600211, DA Project No 1L1161102H60, Pron No. 1A924324GGGG
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Research and Development Command, Large Caliber Weapon System Laboratory, Dover, NJ 07801	12. REPORT DATE: March 1980
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Chrome Plating
LC Chromium
Tensile Strength
Micro Hardness
Adhesion
Pre-treatment
Erosion

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A systematic study was made to optimize conditions for plating high quality LC chromium. The tensile strength, density, hardness, cathode efficiency, and contents of codeposited hydrogen, oxygen, and nitrogen were determined in samples prepared at 85°C and current densities from 60 to 150 A/dm^2. The results indicate that to achieve high strength coatings it was necessary to age the plating solution by a pre-electrolysis of 250 A-hr liter and to use current densities in excess of 120 A/dm^2. Under these conditions, high density

(Continued on next page)

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Continued from Block 20.

crack-free LC chromium can be plated at a rate three times that of conventional HC chromium. The improved LC chromium has been applied on 20 mm liners and test fired in the M24A1 gun. The results showed the LC chromium plated liners had a considerably longer life than the HC chromium plated liners.

The development of a simple qualitative test for evaluating the adhesion of thick brittle deposits to the base metal is described. The test is efficacious in large scale sampling and has been applied to investigate the effects of pretreatment on the adhesion of chromium on gun steel and superalloys. An outgrowth of this work is a new pretreatment for activating superalloys for chromium plating which consists of treating the superalloy anodically in a solution of sulfuric and hydrofluoric acids. A table is presented for comparing this process with other pretreatments.

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1. REPORT NUMBER: ARLCB-TR-80009
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE *(and Subtitle)*: A WIDE RANGE K EXPRESSION FOR THE C-SHAPED SPECIMEN

5. TYPE OF REPORT & PERIOD COVERED:

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s):
J. A. Kapp, J.H. Underwood
J.C. Newman Jr.- NASA Langley Research Ctr.
Hampton, VA 23665

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
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18. SUPPLEMENTARY NOTES:
Presented to ASTM Taskgroup E24.01.05, 30 Oct 79, Pittsburgh, PA.
To be published in the Journal of Testing and Evaluation.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*:
Calibration
Fracture Mechanics
Fracture Properties
Fracture Testing
Toughness

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*:

A new expression has been developed to calculate K for the C-shaped specimen over a wider range of specimen parameters, namely a/W, X/W, and r_1/r_2, than had previously been available. The rationale used to derive the expression was to utilize known stress intensity factor solutions for short and deep cracks to develop a nondimensional form of K which approaches finite values as a/W goes to both zero and one. Numerical K solution results from prior work were then nondimensionalized to this form with the finite limiting

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20. ABSTRACT (Cont'd)

values, and the dependence of K on a/W was determined by multi-variable, linear regression. The final expression agrees with the numerical K solutions within $\pm$ 1.0% for $.45 \leq a/W \leq .55$ for all r_1/r_2 and X/W of either 0 or .5; within $\pm$ 1.5% for $.2 \leq a/W \leq 1$ for all r_1/r_2 and X/W equal to 0 or .5; and within about $\pm$ 3% for $.2 \leq a/W \leq 1$ for all r_1/r_2 and $0 \leq X/W \leq 1$. The accuracy of this expression will allow expanded use of the C-shaped specimen for R-curve determination and fatigue crack growth rate testing.

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1. REPORT NUMBER: ARLCB-TR-80010	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: STRESS CONCENTRATIONS IN SCREW THREADS	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): G. P. O'Hara	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Research and Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervlietn N.Y. 12189	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 4111.16.2991.6 PRON No. 1A-9-39362-Y
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801	12. REPORT DATE: March 1980 13. NUMBER OF PAGES: 41
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18. SUPPLEMENTARY NOTES

Presented at the 8th NASTRAN Users' Colloquium, Goddard Space Flight Center, Oct 79.
To be published in the proceedings of the 8th NASTRAN Users' Colloquium.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Failure
Fatigue
Lugs
Screw-thread
Stress-Concentration

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The concept of stress concentration in screw threads is defined as a ratio of maximum fillet stress normalized to shear transfer rate. The data is presented as a plot of fillet stress vs. radial stress for a particular thread form. The Heywood equation is used to generate the basic plots and NASTRAN is used to extend the analysis to the case both where flanks of an individual thread tooth are in contact and the case where a finite axial stress is superimposed.

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1. REPORT NUMBER ARLCB-TR-80011	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Benefits of Overload for Fatigue Cracking at a Notch		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. H. Underwood J. A. Kapp		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Research and Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervliet, N.Y. 12189		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6446.30.0640.0 DA Project. PRON No. 4A0216591A1A
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon System Laboratory Dover, New Jersey 07801		12. REPORT DATE May 1980 13. NUMBER OF PAGES 24
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18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Fatigue Crack
Residual Stress
Fracture Mechanics
Notch
Overload

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Tests are described which measure the effect of compression overload on fatigue crack initiation and growth from a 0.1 mm radius notch in alloy steel K_{Ic} specimens. Other tests are described which measure the effect of tension overload on fatigue crack initiation and growth from a 3.4 mm root radius notch in similar specimens. The effect of overload on the number of cycles required for crack growth is described for both types of tests in relation to a residual stress model.

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1. REPORT NUMBER: ARLCB-TR-80012	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Review of Recent Literature on Palladium Hydrides	5. TYPE OF REPORT & PERIOD COVERED
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): D. M. Gray	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Armament Research and Development Command, Benet Weapons Laboratory, DRDAR-LCB-TL, Watervliet, N.Y. 12189	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 611102H600011; DA Project. 1461102HA60; PRON No. 1A0215601A1A
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Superconductivity
Enhanced T_c
Palladium
Hydrides

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The motivation for this report is to collect my ideas, reviews of other people's articles, computations, etc. re superconductivity in the Pd-M-H systems (where M is a metal, particularly a noble metal). This is not meant to be anything close to an exhaustive review (see particularly the article by Stritzker and Wuhl in "Hydrogen in Metals II," Eds. Alefeld and Volkl, 1978, Reference 1 and A. C. Switendick, Ibid, Reference 1A). The main purpose is simply to examine and tie together a number of separate ideas and define areas of critical experimentation to test these ideas.

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1. REPORT NUMBER ARLCB-TR-80013	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Austenitizing Behavior of a Low Alloy Steel		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Peter A. Thornton		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Research and Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervliet, N.Y. 12189		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 3110T12000 DA Project. PRON No. 1A8241721A1A
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon System Laboratory Dover, New Jersey 07801		12. REPORT DATE May 1980 13. NUMBER OF PAGES 27
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Austentizing Behavior
Low Alloy Steel Forgings
Chemical Segregation
Heat Treatment

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The austenitizing behavior of a low alloy steel was examined from both the microstructual and the mechanical property standpoint. The temperature range over which austenitizing took place was accurately determined by metallographic and analytical techniques.

Metallographic evidence showed that the dissolution of carbide continues after the crystallographic transition is completed. Also, the dissolution of the preponderance of carbide coincides with a "leveling-off" trend in mechanical

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20. ABSTRACT (Cont'd)

property response, viz., yield strength and Charpy impact toughness.

The data demonstrated that a minimum temperature of 774° C (1425° F) can sufficiently austenitize this steel under the appropriate conditions. However, because of chemical segregation invariably found in large forgings, it is sound practice to allow some contingency in the heat treatment parameters that will consistently provide an adequate austenitizing condition in the thickest sections of a component.

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-TR-80014

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): Electrodeposition of Tantalum and Tantalum Chromium Alloys

5. TYPE OF REPORT & PERIOD COVERED

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s):
I. Ahmad
W. A. Spiak
G. J. Janz

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
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18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Gun Erosion
Refractory Metals
Tantalum
Tantalum-Chromium Alloys
Chromium
Coating
Fused Salt Electrolyte
Electrodeposition
FLINAK

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

As a part of a program to develop erosion resistant coatings for advanced gun barrels, electrodeposition of tantalum and tantalum-chromium alloys from fused FLINAK (eutectic mixture of LiF-KF-NaF) has been investigated. Tantalum-chromium alloys containing 2-6% chromium were obtained by codepositing tantalum and chromium from an electrolyte containing 10 wt% TaF_5 (added as K_2TaF_7) and 0.5-1.5% Cr (added as CrF_3), at 800°C and 15-40 ma/cm^2 current density. The alloy coatings were smooth and columnar in structure. The microhardness of these coatings increased with the increase of chromium content.

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1. REPORT NUMBER ARLCB-MR-80015	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Comparison of Mechanical Properties of 105MM M68 Gun Tube Forgings		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) H. J. Powis		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Research & Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervliet, N.Y. 12189		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 32970675888 PRON No. 1A7270501A1A
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research & Development Command Large Caliber Weapon System Laboratory Dover, New Jersey 07801		12. REPORT DATE May 1980 13. NUMBER OF PAGES 22
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Cannon Tubes
ESR
Rotary Forging
Gun Steel

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

105mm M68 gun tube forgings are supplied at present by two vendors and the Watervliet Arsenal rotary system. A study was initiated to compare mechanical properties of the most recent vendor-supplied tubes with those supplied by them in the past. The vendor-supplied tubes were produced from vacuum degassed steel, whereas the rotary forged tubes were produced from electroslag remelted (ESR) steel. The study shows that the quality of tubes, in terms of mechanical properties varies between vendors, but that the quality from each vendor has remained fairly constant. The study also shows that the tubes produced from ESR are equivalent to those produced by conventional forging and heat treating techniques.

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1. REPORT NUMBER: ARLDB-TR-80016	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: A Proposed Standard Round Compact Specimen for Plane Strain Fracture Toughness Testing	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): J. H. Underwood, J. C. Newman, Jr., R. R. Seeley	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Armament Rsearch & Development Command, Benet Weapons Laboratory, DRDAR-LCB-TL, Watervliet, N.Y. 12189	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 61102H420011, DA Project 1L161102AH42, PRON No. 1A927034GGGG
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18. SUPPLEMENTARY NOTES

To be published in the Journal of Testing and Evaluation

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Fracture Toughness
Standard Specimen
Round Bar
Stress-Intensity Factor

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A round, disk-shaped specimen is proposed as a standard K_{Ic} test specimen for addition to ASTM Method E-399. The specimen is diametrically cracked, and it is loaded in the same general way as the existing standard compact specimen.

Tests and analyses are described which were performed to verify that the proposed round compact specimen and associated K solution are appropriate for a standard K_{Ic} test. The use of the round compact specimen for other fracture tests is described.

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1. REPORT NUMBER: ARLCB-TR-80017	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): STRESS ANALYSIS OF A MORTAR BASEPLATE AS THE BASIS FOR FATIGUE TESTING	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): G. P. O'Hara	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Benet Weapons Laboratory, Watervliet Arsenal, Watervliet, NY 12189, DRDAR-LCB-TL	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 20801534000, PRON No. 1A7327Y2GGM7
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Research and Development Command, Large Caliber Weapon Systems Laboratory, Dover, NJ 07801	12. REPORT DATE: May 1980
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Stress
Fatigue
Mortars
Baseplate
Strain
Soil
Spectrum

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report uses a 5155 degree of freedom static finite element model of the M3 mortar baseplate to provide stress information for a fatigue test design. By using 13 different loading cases and three different soil approximations it is shown that fatigue life varies greatly with different firing conditions. This data also compares favorably with strain gage field test results. A method of designing the fatigue test is suggested; however, it could not be carried out because of a lack of data on field use. A test procedure is suggested based on available information.

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1. REPORT NUMBER ARLCB-TR-80018	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) STRESS ANALYSIS OF AN OVERLOADED BREECH RING		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) P. C. T. Chen and Y. F. Cheng		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 36KA7000204 DA Project No. 156401813GRN PRON No. 1A0215641A1A
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

To be presented at International Conference on Reliability, Stress Analysis and Failure Prevention at Hilton Hotel, San Francisco, 18-21 August 1980. To be published in Proceedings of the Conference, ASME Transactions.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Breech Ring
Photoplasticity
Finite Element Analysis
Residual Stress
Failure Prevention

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A two-dimensional model of the meridian section of a breech ring was made of a photoplastic material which had been calibrated optically and mechanically. The location and magnitude of the maximum fillet stress in an overloaded breech ring was determined experimentally and numerically. Residual stress resulting from elastic unloading was calculated. The comparison between numerical and experimental results is satisfactory.

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1. REPORT NUMBER: ARLCB-TR-80019

2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): VARIATIONAL METHODS OF CONVOLUTION INTEGRAL AND OF LARGE SPRING CONSTANTS - A NUMERICAL COMPARISON

5. TYPE OF REPORT & PERIOD COVERED:

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): Julian J. Wu

8. CONTRACT OR GRANT NUMBER(s):

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12. REPORT DATE: June 1980

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18. SUPPLEMENTARY NOTES

Presented at the Army Numerical Analysis & Computer Conference, NASA Ames Research Center, Moffett Field, CA, 20-21 February 1980.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Variational Methods
Finite Elements
Convolution Integrals
Initial Value Problems

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Finite element solution formulations have been carried out for a simple initial value problem based on two different variational statements: that of convolutional integral developed by Gurtin and that of large spring constants adapted by this writer for initial value problems. Numerical results indicate that both generate convergent solution to the given initial value problem of a spring-mass system subjected to a harmonic forcing function.

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-TR-80020

2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): FACTORS INFLUENCING THE DURABILITY OF CHROME PLATE

5. TYPE OF REPORT & PERIOD COVERED:

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): R. S. Montgomery and F. K. Sautter

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
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18. SUPPLEMENTARY NOTES:
Presented at the International Conference on Wear of Materials 1979, Dearborn, Michigan, April 1979.
Published in technical journal Wear, Volume 60, 1980, pages 141-148.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number):
Electroplating
Chromium
Wear
Bainite

20. ABSTRACT (Continue on reverse side if necessary and identify by block number):
The bores of many cannon tubes are electroplated with chromium. This is done to provide better resistance to erosion and wear and in the case of naval guns to provide corrosion resistance as well. The resistance of chrome plate to erosion and wear is so good that there is little or no wear of the bore until the chromium begins to spall off the steel substrate. In the present research the effects of various factors on the durability of the plate were investigated using a geared roller test machine. It was found that the

20. Abstract (Cont'd)

important stress is the shear stress in the plane normal to the direction of rolling rather than the maximum shear stress; this corresponds to the maximum shear strain. This result has application to the subcase fatigue or "case crushing" failure of case-hardened gears. The failure on repeated loading was found to be in the substrate steel immediately below the interface rather than at the interface itself. The durability of the plated surface decreased by about half as its thickness was increased from 0.15 to 0.41 mm although most or all of this can be attributed to the increased shear stress near the interface for the thicker electroplates. It was also found that residual compressive stress in the substrate steel had a great effect on durability; even the mild residual compressive stress introduced into the steel surface by sand blasting before plating increased durability many-fold. Finally it was found that a bainite microstructure rather than the usual tempered martensite caused a significant decrease in durability.

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-TR-80021
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): SURFACE CRACK K-ESTIMATES AND FATIGUE LIFE CALCULATIONS IN CANNON TUBES

5. TYPE OF REPORT & PERIOD COVERED:

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): J. H. Underwood and J. F. Throop

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS
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Benet Weapons Laboratory, DRDAR-LCB-TL
Watervliet, N.Y. 12189

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11. CONTROLLING OFFICE NAME AND ADDRESS
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18. SUPPLEMENTARY NOTES

Published in Special Technical Publication 687, Copyright 1979, American Society for Testing and Materials, Philadelphia, Pennsylvania.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Fracture Mechanics
Surface Crack
Fatigue Life
Residual Stress
Pressurized Cylinder
Crack Propagation
Fatigue (Material)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

K solutions for internal surface cracks in pressurized cylinders are compared, including Smith's photoelastic results, Hussain's collocation and compliance results, and Underwood's estimates. Fatigue crack growth observations from cannon tubes are described, particularly in relation to surface crack growth and multiple cracks.

A method is proposed for describing quantitatively the effect of residual stress on K in cylinders with shallow cracks. The combination of compressive residual stress with applied stress reduces ΔK and thus increases fatigue life.

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-MR-80022	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): DESIGN AND CONSTRUCTION OF A REFINED STEP THREADING MACHINE FOR 175mm AND 8" BREECH RINGS	
5. TYPE OF REPORT & PERIOD COVERED	
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): C. H. Rose	
8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Armament Research and Development Command, Benet Weapons Laboratory, DRDAR-LCB-TL, Watervliet, N.Y. 12189	
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11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Research and Development Command, Large Caliber Weapon Systems Laboratory, Dover, New Jersey 07801	
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18. SUPPLEMENTARY NOTES

Originally submitted as an MM&T project to U.S. Army Armament Materiel Readiness Command in April 1980.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Thread Cutting
Step Threads
Thread Shaping
Form Tool Threading

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report details the engineering design and production application of a special purpose machine, tooled to produce internal step threads (constant lead thread on two distinct diameters) on 8" M201 breech rings. The machine, using oscillating motion and a full thread form tool, produces the full thread on each sector, then is indexed in turn to the next sectors until all eight (8) are complete. The use of this equipment has reduced the floor to floor time from 13 hours to 4 hours while producing better thread finishes and more accurate dimensional sizes.

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1. REPORT NUMBER: ARLCB-TR-80023	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: LASER TREATMENT OF CHROMIUM PLATED STEEL	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): R. S. Montgomery	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Armament Research and Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervliet, N. Y. 12189	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611102H6002 DA Project No. 1L1161102H60 PRON No. 1A9243241A1A
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801	12. REPORT DATE: June 1980 13. NUMBER OF PAGES: 12
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18. SUPPLEMENTARY NOTES

Presented at the 4th International Tribology Conference, Paisley, 10-15 September 1979.
Published in technical journal Wear, Volume 56, 1979, pages 155-166.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Electroplating
Chromium
Wear
Heat Affected Zone
Laser Treatment

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Both flat steel coupons and rolls for a geared-roller test machine were chromium plated and laser treated in an effort to improve adhesion. Under the experimental conditions the electroplate was rendered considerably softer but more fragile. A Cr-Fe alloy was produced at the interface at the slower processing speeds and the steel under the electroplate was considerably hardened by the formation of untempered martensite. While this work shows only much decreased durability for laser-treated chrome plate, perhaps other experimental conditions might show improved properties.

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1. REPORT NUMBER ARLCB-TR-80024	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* A MATHEMATICAL MODEL FOR PRODUCTION SIMULATION		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) E. E. Coppola		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Research and Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervliet, N.Y. 12189		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 3291.06.7751 DA Project. PRON No. M1-7-P0873-M7M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon System Laboratory Dover, New Jersey 07801		12. REPORT DATE July 1980 13. NUMBER OF PAGES 49
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Computerized Simulation
Mathematical Model
Production Model
Production Scheduling

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A mathematical model has been developed to simulate the production lines at Watervliet Arsenal. Inputs to the model include the steps required to transform raw material into a finished product and the resources available for production. From these data, the model will predict such things as the number of items produced by the line, utilization of machines and workers and areas where the number or quality of the resources are not adequate to meet the desired production goals.

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1. REPORT NUMBER: ARLCB-TR-80025	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: A PHOTOELASTOPLASTIC STUDY OF STRESS CONCENTRATION FACTORS AND RESIDUAL STRESSES IN TWO NOTCHED SPECIMENS OF POLYCARBONATE MATERIAL	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Y. F. Cheng	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 36KA7000204 DA Project No. 156401813GRN PRON No. 1A0215641A1A
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Photoelasticity	Residual Stress
Photoplasticity	C-Shaped Specimen
Stress Concentrations	Compact Tensile Specimen

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A photoelastoplastic study on stress concentrations, in elastic as well as in elastoplastic states, in a C-shaped specimen and a compact tensile specimen of polycarbonate material has been made. The principles of the experimental method are outlined, equations for nominal stresses are given, and stress concentration factors are determined. Residual stresses after unloading are calculated by making the usual assumption that unloading is an elastic process. In the elastic

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state, stress concentration factors are readily applicable to specimens of any material with similar geometry and loading. In the elastoplastic state, it requires the similarity of stress-strain relation between model and prototype materials.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-80026	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* FRACTURE TESTS AND ANALYSIS OF WARHEAD BASE OF 155 MM M549A1 PROJECTILE		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Joseph F. Throop, Robert R. Fujczak, and Ronald T. Abbott		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 612105H840011 DA Project No. 1L162105AH84 PRON No. 1A0217131A1A
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

RAP Projectile	Hydro-test
Fracture	Launch
Critical Flaw	Acceleration
Inspection	Temperature

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

An experimental study was conducted to evaluate the propensity for brittle fracture of the warhead base of the 155 mm Rocket Assisted Projectile M549A1 during launch and to provide samples with known flaw sizes for use in calibration of inspection devices. The experiments also determined the hydrostatic proof test pressure required to fracture the smallest flaw that would be critical at the most severe launch temperature. Fracture mechanics failure analyses and plane strain fracture of the base were confirmed by the experiments.

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1. REPORT NUMBER ARLCB-TR-80027	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) STUDY OF EROSION RESISTANT MATERIALS FOR GUN TUBES PART I: 20 MM LINER TECHNOLOGY		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. L. Cullinan, G. D'Andrea, P. Croteau, and C. Arnold		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 64366280071212 DA Project No. 1W463628D00
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Gun Tube Erosion	Tantalum Coatings
Shrink-Fit Liners	20 MM M24A1
Bore Plating	Erosion Protection

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The major criteria for the condemnation of gun tubes is based on the excessive erosion of the bore which results in loss of range and accuracy. Gun tube erosion is caused by several thermal, mechanical, and chemical factors interacting during the firing cycle. One approach to minimize erosion is to line gun barrels with wear resistant materials. This work introduces a shrink fit liner concept in the 20 mm M24A1 gun system. Liners analyzed are steel, Cr/steel, Ta/steel, Ta/stellite. Preliminary firing results, under similar test conditions, indicate that the Ta/steel combination reduces erosion in the 20 mm gun system.

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1. REPORT NUMBER ARLCB-TR-80028	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) GENERALIZED PLANE-STRAIN PROBLEMS IN AN ELASTIC-PLASTIC THICK-WALLED CYLINDER		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) P. C. T. Chen		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 36KA7000204 DA Project No. 156401813GRN PRON No. 1A0215641A1A
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18. SUPPLEMENTARY NOTES

Presented at the 26th Conference of Army Mathematicians, Cold Regions Research and Engineering Lab, Hanover, New Hampshire, 10-12 June 1980.
To be published in proceedings of the conference.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Autofrettage
Elastic-Plastic Deformation
Finite-Difference Method
Gun Tube

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A new finite-difference approach has been developed for solving the generalized plane-strain problems of partially-plastic thick-walled cylinders made of strain-hardening or ideally-plastic materials. The tube is assumed to obey the Von Mises' criterion, the Prandtl-Reuss flow theory and the isotropic-hardening rule. The forces include internal pressure, external pressure, and end force. An incremental approach is used and no iteration is needed for each increment. The approach is simpler than others yet quite general and accurate.

CONT'D ON REVERSE

20. Abstract (CONT'D)

The desired accuracy can be achieved by reducing the grid sizes and load increments. Some numerical results for the stresses and displacements in partially-plastic thick-walled cylinders with either open-end or closed-end conditions are presented.

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1. REPORT NUMBER ARLCB-TR-80029	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) STRAIN BEHAVIOR OF PRESSURIZED CRACKED THICK-WALLED CYLINDERS		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. F. Throop and R. R. Fujczak		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 612105H840011 DA Project No. 1L162105AH84 PRON No. 1A0217131A1A
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, NJ 07801		12. REPORT DATE August 1980 13. NUMBER OF PAGES 26
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

To be published in Experimental Mechanics.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Fatigue Cracks
Crack Shape
Thick Wall Cylinders
Strain Measurements
Autofrettage
Lamé Strain
Ultrasonics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

External circumferential strains were measured on large thick wall pressure vessels containing internal fatigue cracks, using bonded strain gages. When strains measured over the cracks become compressive they predict impending failure. Normalization by the Lamé strain relates them to the fraction of fatigue life consumed and provides estimates of longevity.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-80030	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* AN EXPERIMENTAL INVESTIGATION OF STRESSES IN A STEEL MODEL OF AN OVERLOADED BREECH RING BY MEANS OF PHOTOELASTIC COATING TECHNIQUE		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Y. F. Cheng		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 36KA7000204 DA Project No. 156401813GRN PRON No. 1A0215641A1A
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, NJ 07801		12. REPORT DATE August 1980 13. NUMBER OF PAGES 22
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Breech Ring
Photoelastic Coating
Residual Stress
Stress Concentration Factor

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

An experimental investigation of stresses at the lower fillet in a two dimensional steel model of an overloaded breech ring by means of photoelastic coating technique has been made. The basis of the technique is given. Expressions for stress and strain in both the elastic and elasto-plastic state are derived. Maximum fillet stress, stress concentration factor, as well as the residual stress after unloading were found. The results were compared with previous data from polycarbonate model.

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: ARLCB-TR-80031
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE *(and Subtitle)*: ANALYSIS OF SHIFTS IN THE POINTS OF MAXIMUM DEFLECTION AND PERMANENT DEFLECTION FOR ELASTIC-PLASTIC BENDING OF UNSYMMETRICALLY LOADED BEAMS

5. TYPE OF REPORT & PERIOD COVERED:

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): R. V. Milligan

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Benet Weapons Laboratory
Watervliet Arsenal, Watervliet, NY 12189
DRDAR-LCB-TL

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
AMCMS No. 612105840011
DA Project No. 1L162105AH84
PRON No. 1A0217131A1A

11. CONTROLLING OFFICE NAME AND ADDRESS:
US Army Armament Research and Development Command
Large Caliber Weapon Systems Laboratory
Dover, NJ 07801

12. REPORT DATE: August 1980

13. NUMBER OF PAGES: 17

14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*:

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18. SUPPLEMENTARY NOTES:

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*:
Beams
Plasticity
Elastic-Plastic Analysis
Bending
Deflection

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*:
An analysis of elastic-plastic bending of unsymmetrically loaded beams is carried out using the method of virtual work. The results show that the maximum deflection under load occurs at quite some distance from the point of loading but moves toward the point of loading as the load approaches ultimate. The residual or permanent deflections occur at points different than those developed under load and are shifted further toward the load point. However, even at a load equal to 99.5% of the ultimate the maximum permanent deflection still occurs
(CONT'D)

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Block 20. Abstract

at a considerable distance from the point of loading. The maximum strains (under load) and the permanent strains occur at the point where the load is applied.

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-TR-80032 (Rev.)
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): MUZZLE FAILURE ANALYSIS
105 mm M68 Ser #26925

5. TYPE OF REPORT & PERIOD COVERED:

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): Bruce B. Brown and Howard D. McAlonie

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Benet Weapons Laboratory
Watervliet Arsenal, Watervliet, NY 12189
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10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
AMCMS No. 3111.15.11000
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11. CONTROLLING OFFICE NAME AND ADDRESS:
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12. REPORT DATE: August 1980

13. NUMBER OF PAGES: 24

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES
This report is reissued to upgrade the quality of the illustrations.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Cannon 105 mm M68
Tank M60A1
Failure Analysis
Cannon Barrel Failure

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
An engineering and metallurgical study has been made of 105 mm M68 barrel muzzle that fractured during firing. The barrel steel was within specification limits in mechanical properties, chemistry and cleanliness. The failure is attributed to excess stress in a hoop direction and prior cracking. A residue of aluminum and propellant debris was found adhering to crack surfaces.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-MR-80033	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* An End Item Manufacturing Process Guide (A Functional Cost Analysis of Manufacturing Operations)		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)* Harold Goodheim		8. CONTRACT OR GRANT NUMBER*(s)*
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Research and Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervliet, N. Y. 12189		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS DA Project No. 6717042
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE August 1980 13. NUMBER OF PAGES 8
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Manufacturing
Processes
Functional Classification

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The objective of this study was to develop a systematic procedure for pinpointing areas for future funding requests aimed at improving production methods. The approach taken was to describe current manufacturing processes in terms of the functions they performed, thus allowing assessment of costs without reference to the methods employed. Such "technology-independent" assessment allowed cost comparison both within and among end items, thereby highlighting the high-cost functions.

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20. Abstract (Cont'd)

Based on available data a procedure was designed for developing the Process Analysis Structure - an interrelated set of nine tables which become the analyst's raw materials in the search for new combinations of operations and for high-cost production functions. This procedure including a new method for indirect cost allocation, was validated with actual data relating to the manufacture of the 105mm M68 gun tube.

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-TR-80034
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): FATIGUE TEST, 155 MM M199 BARREL
5. TYPE OF REPORT & PERIOD COVERED:
6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): Bruce B. Brown
8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Benet Weapons Laboratory
Watervliet Arsenal, Watervliet, NY 12189
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10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
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11. CONTROLLING OFFICE NAME AND ADDRESS:
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12. REPORT DATE: December 1980
13. NUMBER OF PAGES: 25

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cannon, 155 mm M199	Ultrasonic Inspection
Howitzer, 155 mm M198	Fracture Toughness
Fatigue Testing	Fatigue Cracking
Safe Fatigue Life	Fatigue Failure

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
A fatigue study has been made of the 155 mm M199 barrel to assess the safe fatigue life under conditions of maximum pressure firing zone (Zone 8S).

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-SP-80035	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* INDEX TO BENET WEAPONS LABORATORY (LCWSL) TECHNICAL REPORTS - 1979		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. D. Neifeld		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE September 1980 13. NUMBER OF PAGES 91
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This is a compilation of technical reports published during 1979.

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: ARLCB-TR-80036	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): AN ADAPTIVE ALGORITHM FOR EXACT SOLUTION OF AN OVERSTRAINED TUBE	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): P. C. T. Chen	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Benet Weapons Laboratory, Watervliet Arsenal, Watervliet, NY 12189, DRDAR-LCB-TL	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 36KA7000204, DA Project No. 156401813GRN, PRON No. 1A0215641A1A
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Research and Development Command, Large Caliber Weapon Systems Laboratory, Dover, NJ 07801	12. REPORT DATE: September 1980
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18. SUPPLEMENTARY NOTES

Presented at 1980 Army Numerical Analysis and Computer Conference, NASA Ames Research Center, Moffett Field, California, 20-21 February 1980. Published in proceedings of the conference.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Elastic-Plastic Deformation
Finite-Difference Method
Gun Tube
Residual Stresses

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An adaptive algorithm to generate an exact solution has been developed for the plane-strain problem of a thick-walled tube overstrained by internal or external pressure. The material obeys the von Mises' yield criterion, the Prandtl-Reuss flow theory and the isotropic hardening rule. The ideally-plastic material is treated as a special case. The formulation is based on the finite-difference

(CONT'D ON REVERSE)

20. Abstract (CONT'D)

method in conjunction with a scaled incremental-loading approach. One additional grid point will become yielded in each load step. The grid sizes and load increments are determined in the program. For a given percentage of overstrain and a desired solution necessary, the stresses and strains can be obtained in an efficient way.

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARLCB-TR-80037	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: DETERMINATION OF PHASE TRANSFORMATION TEMPERATURES OF TITANIUM-NICKEL USING DIFFERENTIAL THERMAL ANALYSIS	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): R. Vincent Milligan	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Benet Weapons Laboratory, Watervliet Arsenal, Watervliet, NY 12189, DRDAR-LCB-TL	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS No. 611102H420011, DA Project No. 1L161102AH42, PRON No. 1A0217141A1A
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Research and Development Command, Large Caliber Weapon Systems Laboratory, Dover, NJ 07801	12. REPORT DATE: October 1980
	13. NUMBER OF PAGES: 18
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18. SUPPLEMENTARY NOTES

Published in Proceedings of Fourth International Conference on Titanium, Kyoto, Japan, 19-22 May 1980.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Nickel
Titanium
Nickel-Titanium
Differential Thermal Analysis
Phase Transformations

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Some of the more popular methods used to determine phase transformations in metals are x-ray, dilatometry, and electrical resistivity. Data reported for the TiNi alloy using Differential Thermal Analysis (DTA) is quite sparse and it appears that little effort has been made to correlate these results with x-ray, dilatometry, or resistivity data. The purpose of this investigation was to determine the M_s and A_s temperatures for several alloys having compositions

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20. Abstract (Cont'd)

near 50 atomic percent titanium. The DTA method was used. The results are compared with those reported by several investigators that used different techniques. The DTA data obtained shows excellent agreement with Kornilov's A_s temperatures,[1] as a function of composition, obtained by dilatometry. A small variation was found between the results of this study and Wasilewski's x-ray data,[2] and Hanlon's resistivity measurements[3] for the M_s temperatures. It is concluded from this investigation that DTA analysis is a credible method for determining phase transformation temperatures for the TiNi material.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-80038	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* FLUX EXCLUSION IN CdS AT 77 K: SUPERCONDUCTIVITY AT HIGH TEMPERATURES?		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(e) E. Brown, C. G. Homan R. K. MacCrone - Rensselaer Polytechnic Institute, Troy, New York 12180		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6111.02.H600 DA Project No. 1L161102AH60 PRON No. 1A-0-3ZB04-NMLC
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research & Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE October 1980 13. NUMBER OF PAGES 4
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18. SUPPLEMENTARY NOTES

Published in Physical Review Letters, Volume 45, Number 6, 11 August 1980, pages 478-481.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Excitonic Solids
Superconductivity
Flux Exclusion
High Pressure
Semiconducting Materials

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The observation of flux exclusion approaching Meissner proportions ($\chi_V = -1/4\pi$ cgs units) in pressure-quenched CdS at 77 K is reported. The results can be naturally and simply interpreted on the basis of superconductivity at 77 K. If the superconductive state is not the appropriate description, then a new high-temperature collective quantum state must be invoked.

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1. REPORT NUMBER ARLCB-MR-80039	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* MECHANICAL PROPERTIES OF ROTARY FORGED SOLID ESR PREFORMS		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) F. A. Heiser		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Research and Development Command Benet Weapons Laboratory, DRDAR-LCB-TL Watervliet, N.Y. 12189		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 3297.06.7588 PRON No. M1-7-P2913-M11A
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE October 1980 13. NUMBER OF PAGES 48
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Electro Slag Refining (ESR)
Rotary Forging
Steel

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Electro Slag Refined steel which had been rotary forged from a solid 20 inch cast ingot into a solid 13 inch diameter cylinder was evaluated metallographically and mechanically. It is shown that the degree of working is not uniform across the cross section, being greatest near the ID and least near the center. This degree of working manifests itself in the ductility but not in the strength or impact toughness. Normalizing, prior to quench and temper, lowered the yield strength slightly, but markedly improved both the toughness and ductility.

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1. REPORT NUMBER ARLCB-TR-80040	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* NUMERICAL PREDICTION OF RESIDUAL STRESSES IN AN OVERLOADED BREECH RING		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) P. C. T. Chen		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, NY 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 36KA7000204 DA Project No. 156401813GRN PRON No. 1A0215641A1A
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research & Development Command Large Caliber Weapon Systems Laboratory Dover, NJ 07801		12. REPORT DATE October 1980 13. NUMBER OF PAGES 19
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18. SUPPLEMENTARY NOTES

Presented at 1980 Army Numerical Analysis and Computer Conference, NASA Ames Research Center, Moffett Field, California, 20-21 February 1980. Published in proceedings of the conference.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Breech Ring
Residual Stress
Numerical Technique
Elastic-Plastic

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report describes a numerical technique for predicting the residual stresses in an overloaded breech ring. The numerical approach used is the finite element method based on the incremental stress-strain matrix, for which a computer program is developed. The material behavior is characterized by the von Mises' yield criterion, Prandtl-Reuss flow equations and isotropic hardening rule. A piecewise linear representation for the stress-strain

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20. Abstract (Cont'd)

curve is used. The numerical results of the stresses in all elements are obtained for four contact conditions. The location and magnitude of the maximum fillet stress are determined as a function of loading. Residual stresses resulting from elastic unloading are calculated. A satisfactory agreement between numerical and experimental results has been reached.

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1. REPORT NUMBER: ARLCB-MR-80041	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: EFFECT OF OVERSTRAIN IN AUTOFRETTAGE UPON MECHANICAL PROPERTIES OF GUN TUBES	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): H. Goodheim, L. Alix, Dr. V. Colangelo	8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Autofrettage
Mechanical Properties
Residual Stress
Yield Strength

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A study was undertaken to determine the effect of excessive and normal overstrain on mechanical properties in gun tubes.

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3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: FAILURE ANALYSIS - 105mm M68 (SERIAL NUMBER 17759)	5. TYPE OF REPORT & PERIOD COVERED
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7. AUTHOR*(s)*: S. Tauscher	8. CONTRACT OR GRANT NUMBER*(s)*
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Blockage
Catastrophic Failure
Mechanical Properties
Projectile
Yield Strength

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

On 26 October 1978, a 105mm M68 gun tube, SN 17759, failed during the firing of a training round. A failure analysis investigation was undertaken consisting of visual examination, metallography, mechanical property evaluation and chemical analysis. The investigation established that the tube exhibited good mechanical properties, did not contain a pre-existing material defect, and did not fail by an in-bore premature detonation of the projectile. This investigation also concluded that it is possible that

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20. Abstract (Cont'd)

something blocked the projectile and allowed the in-bore pressure to build up to a level which exceeded the strength of the tube at the location of the failure.

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4. TITLE *(and Subtitle)* ELASTIC-PLASTIC ANALYSIS OF SCREW THREADS		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) G. P. O'Hara		8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Screw Threads
Lugs
Stress
Plastic
Elastic

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

An elastic-plastic analysis method is suggested for screw thread teeth. In this method a single tooth is analyzed using boundary conditions to simulate a long chain of identical teeth. A set of five different loads are suggested to simulate pressure and shear on each flank along with a general stress field in the component. An example is worked out for a British Standard Buttress thread form. Data is presented from the example to show that friction is a very important parameter.

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3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: QUADRATIC AND CUBIC TRANSITION ELEMENTS	5. TYPE OF REPORT & PERIOD COVERED
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): M. A. Hussain J. D. Vasilakis S. L. Pu	8. CONTRACT OR GRANT NUMBER(s)
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Submitted for publication in International Journal for Numerical Methods in Engineering.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Finite Elements
Transition Elements
Stress Intensity Factors

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Based on the investigations of Barsoum,[1] Henshell and Shaw,[2] quarterpoint quadratic elements have been successfully used as crack tip elements in fracture mechanics. This concept of singular element was extended to cubic isoparametric elements.[3] Recently it was discovered by Lynn and Ingraffea[4] that under special configuration, transitional elements improve the accuracy of stress intensity factor computations. In this report, we have obtained

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20. ABSTRACT (Cont'd)

the location of mid-side nodes of these transitional elements for the quadratic as well as cubic elements. The cubic transitional elements were used for the double-edge crack problem, and it was found that there was improvement in accuracy for a configuration which consisted only of singular and transitional elements. However, for a well laid out grid, the improvement was only marginal.

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7. AUTHOR(s): P. C. T. Chen	8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

NASTRAN Program
Triangular Ring
Elastic-Plastic
Gun Tube
Thread Problem

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

An elastic-plastic triangular ring element is implemented in the NASTRAN computer program. The plane-strain problem of a partially-plastic thick-walled cylinder under internal pressure is solved and compared with the earlier finite-difference solution. A very good agreement has been reached. In order to demonstrate its application to more general problems, an overloaded

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20. Abstract (Cont'd)

thread problem for the British Standard Buttress is examined. The maximum axial and principal stresses are located and their values are determined as functions of loading.

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2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): BEAM MOTIONS UNDER MOVING LOADS SOLVED BY FINITE ELEMENT METHOD CONSISTENT IN SPATIAL AND TIME COORDINATES

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7. AUTHOR(s): Julian J. Wu

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Moving Loads
Finite Element
Dynamics
Vibrations
Beam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A solution formulation and numerical results are presented here for the time-dependent problem of beam deflections under a moving load which can be neither a force nor a mass. The basis of this approach is the variational finite element discretization consistent in spatial and time coordinates. The moving load effect results in equivalent stiffness matrix and force vector which are evaluated along the line of discontinuity in a time-length plane. Numerical results for several problems have been obtained, some of which are compared with solutions obtained by Fourier series explanations.

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4. TITLE *(and Subtitle)* FINITE ELEMENTS FOR INITIAL VALUE PROBLEMS IN DYNAMICS		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) T. E. Simkins		8. CONTRACT OR GRANT NUMBER(s)
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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Finite Elements
Dynamics
Boundary Value Problems
Approximations

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The work of C. D. Bailey amply demonstrates that a variational principle is not a necessary prerequisite for the formulation of variational approximations to initial value problems in dynamics. While Bailey successfully applies global power series approximations to Hamilton's Law of Varying Action, the work herein shows that a straightforward extension to finite element formulations fails to produce a convergent sequence of solutions. The source of the

(CONT'D ON REVERSE)

20. Abstract (Cont'd)

difficulties and their elimination are discussed in some detail and a workable formulation for initial value problems is obtained. The report concludes with a few elementary examples showing the utility of finite elements in the time domain.

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